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THE NATIONAL IGNITION FACILITY (NIF)

AND THE

ISSUE OF NONPROLIFERATION

Final Study
Prepared by the U.S. Department of Energy
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TECHNICAL ANALYSIS OF PROLIFERATION IMPLICATIONS:

A. Overview:

How Does a Thermonuclear Weapon Work?

Modern thermonuclear weapons consist of two stages: a *primary* stage (fission trigger) and a *secondary* stage (fusion). The purpose of the primary is to produce x-rays to implode the secondary to ignition conditions. The secondary is the stage that produces high yields for modern U.S. strategic weapons -- typically hundreds of kilotons (kt). The primary contains a subcritical pit of fissile material, generally plutonium, surrounded by a layer of chemical high explosive (HE). The HE is detonated, burns rapidly, and compresses the pit. The implosion of the pit increases the density of the fissile material to super criticality, leading to a fission chain reaction and rapid heating. X-rays from the hot exploding primary are then channeled by a radiation case to the secondary where they implode the secondary.

To increase their efficiency, modern primaries can employ a process called *boosting*. In boosted primaries the pit contains deuterium and tritium (DT) gas that is compressed and heated. The DT gas undergoes fusion producing copious quantities of energetic neutrons that flood the compressed pit. The extra burst of neutrons causes significant additional fission reactions that "boost" the primary yield to a much higher value. If the primary fails to boost properly, its yield may be inadequate to drive the secondary resulting in weapon failure.

The Stockpile Stewardship Mission:

In 1993, President Clinton directed the Department of Energy to maintain the safety, reliability, and performance of the remaining post START II nuclear arsenal without nuclear testing. This Stockpile Stewardship mission requires the means to evaluate existing weapons and could entail certifying rebuilds or re-manufactures of existing weapons for safety and reliability as they age.

To advance the goal of concluding a Comprehensive Test Ban Treaty at the earliest possible date and to secure the strongest possible treaty, President Clinton announced support for a "zero" yield treaty on August 11, 1995. In making this announcement, the President also established the "concrete, specific safeguards that define the conditions under which the United States can enter into a CTBT". Of the six safeguards outlined, the first two relate to the stockpile stewardship program:

"A) Conduct of a Science-Based Stockpile Stewardship program to ensure a high level of confidence in the safety and reliability of nuclear weapons in the active stockpile, including the conduct of a broad range of effective and continuing experimental programs.

B. Vertical Proliferation:

What Weapons Science do U.S. weapons scientists believe is technically possible on NIF?

This section will explore, within classification guidelines, what U.S. weapon scientists believe is technically possible at the NIF for weapons science. Although this represents a summary of the thinking of a broad variety of technical experts over a period of many years, it is always possible that some new or substantially different ideas for research in weapons science may arise in the future.

The weapons-related research possible on NIF spans the following topics:

I. Radiation flow
II. Properties of matter
III. Mix and hydrodynamics
IV. Using ignition for weapons science
V. X-ray laser research
VI. Computer codes
VII. Weapons effects

Not all work which is technically possible at NIF would be done. Some areas of research are speculative and ultimately may prove unfeasible, impractical, or undesirable. For example, experiments on nuclear directed energy weapon concepts, while technically possible to explore in the first phase of NIF operation, are not planned since the Department is not developing new types of nuclear weapons.

Only some of the possible research topics (category IV and VII primarily) require that NIF achieve ignition. A discussion of the weapon physics research, when combined with the civilian research, forms the basis for what is technically possible at NIF and its potential vertical proliferation impact.

A description of each weapons research area follows:

I. Radiation flow: X-radiation emitted by the primary supplies the energy to implode the secondary in all U.S. stockpiled weapons. Understanding the flow of this radiation is important for predicting the effects on weapon performance due to changes that might arise over time. Uncertainties in the physics and the mathematical formulation for radiation flow contribute to the present degree of disagreement between theoretical models of radiation flow and the results of past underground tests. NIF experiments can be done in which radiant energy is monitored as it flows through well-defined, fixed geometries.

A major aim of an experimental radiation flow program at the NIF is to understand the range of applicability of computer models and to obtain data that would allow their refinement in the absence of testing. Radiation flow experiments have been performed in microscopic geometries at the Nova laser. At NIF, higher temperatures are anticipated, and with 40 times the energy of the Nova laser, radiation flow conditions should be closer to those in a weapon. This would permit experiments to be performed in larger, more complicated geometries than at the Nova laser, although still several orders of magnitude smaller than in a real weapon. While the conditions anticipated in NIF experiments would allow research in physical regimes closer to those existing in weapons radiation channels, the actual conditions are still different. Consequently, the results must still be extrapolated or scaled by calculations to compare them with underground test data, and improve the models derived from those tests.

II. Properties of matter: Two properties of matter that are important at the high energy densities of a nuclear explosion are equation of state and opacity. The equation of state is the relationship among a material's pressure, density, and temperature expressed over wide ranges of these variables. Opacity is a fundamental property of how radiation is absorbed and emitted by a material. The correct equation of state is required for the accurate solution of any compressible hydrodynamics problem, including weapons design. Radiation opacities of very hot dense matter are critical to understanding the radiation flow in a nuclear weapon.

Large lasers can access regions of extreme pressure and temperature. Experiments at the Nova laser have generated the highest pressures ever measured in a laboratory, although still much less than the maximum encountered in nuclear weapons. NIF is expected to generate high enough pressures to access conditions more relevant to imploding secondaries. Also, the large energy of NIF will lead to more accurate experiments, since sample sizes will be substantially larger than those on the Nova laser.

Because the matter in a nuclear explosion is so dense and hot, it has been virtually impossible to make relevant laboratory measurements of opacity. Consequently, nuclear test data and theoretical models of opacity provide a knowledge base that still has many uncertainties for predicting weapon performance. Methods have been developed for measuring plasma opacities at the Nova laser in a fairly narrow temperature and density regime and for some of the elements directly applicable to weapons. NIF will allow significantly higher temperatures and will provide opportunities to study elements more directly applicable to weapons, such as depleted uranium. (As mentioned above, physics experiments involving small amounts of heavy material (e.g. depleted uranium) may be considered for the NIF as it is presently designed and may be possible without further National Environmental Policy Act (NEPA) process.) It should then be possible to make direct connection to opacity experiments previously conducted at the Nevada Test Site, and should greatly improve opacity modeling codes for calculating weapon performance. Even with these improved codes, however, U.S. nuclear weapon scientists would not be able to develop new nuclear weapons with confidence in the absence of testing.

III. Mix and hydrodynamics: Hydrodynamic instabilities and the mixing of heavy material with low-density thermonuclear fuels degrade the yield of weapons. Repeated radiochemical measurements in nuclear tests have confirmed such mixing. Unfortunately, the growth of hydrodynamic instabilities into mix is a highly non-linear, chaotic process. There is presently no computer simulation of mix that can predict with complete confidence mixing in weapons. In fact, it is generally recognized that only comparing designs and analyzing past nuclear test data can provide a designer with a tolerable level of confidence in interpreting and applying mix models.

The Nova laser is currently being used to investigate the basic physics of some types of hydrodynamic instabilities. However, energy available from Nova limits the size and the time scale of evolution of mixing to much less than that of a nuclear weapon. NIF should allow studies of mixing more relevant to weapons conditions.

IV. Using ignition for weapons science: Attaining ignition at the NIF would likely open new research topics in weapons science. ICF capsules can be modified from the baseline design to study a number of weapons physics issues on a small laboratory scale, provided the modified capsules ignite and burn. These experiments will require extensive design calculations and would be conducted only after ignition is achieved. If ignition were achieved, U.S. weapon scientists, by using ICF capsules, may be able to study physics related to some phases of boosting. Also, they could study the deleterious effects of hydrodynamics and mix on certain weapons processes and further enhance weapon codes as a result. Since these experiments would be conducted with ICF capsules that operate differently from existing primaries or secondaries, sufficient information could not be garnered from ICF experiments to allow confident development of a new nuclear weapon design. The ability to study the comprehensive physics issues that apply to any weapon, whether similar to current designs or advanced designs, is tenuous, and extrapolating to a functioning new warhead from any scaled NIF data, even with ignition, would not be reliable.

Questions have been raised regarding the applicability of NIF to concepts for pure fusion weapons. For two reasons, NIF would not be sufficient to develop a pure fusion weapon: (1) NIF targets are much too small to be a weapon; and (2) the driving mechanisms and conditions that would be required for a deliverable pure fusion weapon are entirely different than those required for ICF. The fundamental problems in developing the most complicated part of a pure fusion weapon, namely, the driver, have to do with high explosive-driven hydrodynamics, hydrodynamic instabilities and magnetohydrodynamics on a much larger scale.

V. X-ray Laser Research: Livermore Laboratory has an on-going laboratory x-ray laser research effort at the Nova laser for peaceful applications, which is expected to continue on the NIF. Since NIF should be able to attain higher energy X-ray lasers than those achievable on Nova, this opens up the possibility that laboratory X-ray lasers can be developed at NIF that are better suited to perform X-ray microscopy, holography on

biological samples or for X-ray lithography for micro-chip manufacturing.

X-ray lasers have military applications as well as peaceful ones. For example, the results of NIF experiments could provide data for comparison with codes and could be used to further interpret the results of past underground experiments on nuclear-pumped x-ray lasers, but nuclear testing would be necessary to demonstrate that an actual X-ray laser weapon or any other nuclear directed-energy weapon will work as designed. The lasing schemes to be used for peaceful applications are not direct analogues of the nuclear-weapon pumped X-ray laser.

Questions have been raised about the applicability of NIF to the study of some principles of other nuclear driven directed energy weapon concepts such as electro-magnetic pulse (EMP) and microwave weapons. Experiments on nuclear directed energy weapon concepts, while technically possible to explore in the first phase of NIF operation, are not planned. The Department is not developing new types of nuclear weapons. Even from a strictly technical standpoint, experiments on directed energy weapon concepts are considered highly speculative and NIF would only be able to play a very limited role in addressing some of the physics aspects of such weapons, and then, only on a small laboratory scale.

In conclusion, research on X-ray lasers has multiple applications and therefore, it would be unwise to restrict peaceful research in this area in the interest of preventing weapon development. A program to develop any advanced new nuclear weapons at NIF through a series of experiments would be visible to Congress.

VI. Computer Codes: The development of nuclear weapons has depended heavily on use of complex computer codes and supercomputers. The codes encompass a broad range of physics including motion of material, transport of electromagnetic radiation, neutrons and charged particles, interaction of radiation and particles with matter, properties of materials, nuclear reactions, atomic and plasma physics, and more. In general, these processes are coupled together in complex ways applicable to the extreme conditions of temperature, pressure, and density in a nuclear weapon and to the very short time scales that characterize a nuclear explosion.

ICF research requires codes that have some similarities to codes used in nuclear weapons research. However, the very small time and space scales inherent in ICF experiments mean that certain approximations usually employed in standard weapons calculations are not valid. ICF targets will require more accurate computer models in some areas than those useful for weapons. Conversely, some models needed for weapons calculations are not needed for ICF. More time-consuming computations will be needed to adequately represent the physics and develop the engineering requirements needed for ICF ignition.

Code development for ICF, especially as applied to NIF, can assist nuclear weapons science in two ways: providing improved computational methods and physics models (i.e.,

those with improved computational accuracy or the ability to study three-dimensional effects) to address weapon design problems; and designing microscopic weapons physics experiments to be conducted at NIF.

VII. Weapons effects: Nuclear weapons effects used to be investigated by exposing various kinds of military and commercial hardware to the radiation from actual nuclear explosions. These tests were generally conducted in tunnels at the Nevada Test Site and were designed so that the hardware was exposed only to the radiation from the explosion and not the blast. Based upon the data obtained, the equipment was "hardened" to reduce its vulnerability during nuclear conflict.

Without nuclear testing, radiation must be simulated in laboratory research facilities and by numerical calculations. The NIF is currently expected to provide radiation at energies in parts of the X-ray spectrum not available from other facilities and, as such, it would be a valuable complement to the present set of tools for weapons effects. Without ignition, there are several proposals for X-ray production using NIF lasers that may produce X-ray environments of interest for nuclear weapons effects simulation. If ignition is achieved, calculations indicate a significant number of warm X-rays should be possible, substantially more than with present simulators.

Ignition would also provide significant quantities of energetic neutrons that are important to determine the vulnerability of a weapon. The energetic neutrons could in turn be used to produce gamma rays which are also used for studying weapons effects. The neutron output might be enhanced by use of neutron multipliers created by using, for example, a subcritical assembly of fissile material. However, since such multipliers use fissile material, such experiments could not be performed at the NIF without physical upgrade to NIF and further NEPA process, and there is no intention on the part of the Department to pursue these highly speculative experiments.

While many weapons effects applications apply to situations in space or the atmosphere in connection with a conjectured anti-ballistic missile battle involving nuclear interceptors, there have also been many studies involving ground coupling, collateral damage and electro-magnetic pulse effects. NIF will also be able to generate significant shock waves and to cause irradiated matter to reach extreme conditions of temperature and pressure, producing data needed for scaled studies of the effects of shocks and mixing produced by nuclear and conventional explosions. Further study would be needed to consider many of the practical issues required for designing a useful capability for such weapons effects at the NIF, if that were deemed desirable.

C. MANAGING THE VERTICAL PROLIFERATION CONCERN AT NIF:

Some experiments at NIF (approximately 20% of total experiments) will, of necessity, be classified. Classified guidelines for ICF research are discussed in Appendix II. This will make it difficult for the United States to avoid arousing suspicions that the NIF is being used to design new, advanced thermonuclear warheads, and thereby appearing to contribute to vertical proliferation and a new arms race. Countering such suspicions will be one of the chief challenges facing operators of NIF.

There are several ways in which the United States can assure the American public and other countries that NIF is not contributing to vertical proliferation.

(1) Approval and funding commitments from the U.S. Executive Branch and the Congress are required throughout the weapon research and development process. The Administration and the Congress can ensure that the weapons laboratories are not engaging in research and development at NIF that encourages vertical proliferation or contravenes U.S. policy.

(2) Section 3152 of P.L. 103-337, entitled "Approval for Certain Nuclear Weapons Activities", requires the Nuclear Weapons Council, through the Secretary of Energy, is required to submit to the Congressional Defense Committees a report, in classified form, which describes all of the activities conducted by the DOE during that fiscal year, or planned to be conducted in the next fiscal year for "the study, development, production, and retirement of nuclear warheads". This report shall include a description of "the degree to which such activity or study is consistent with United States policy for new nuclear warhead development or warhead modification and with established or projected military requirements." Thus, Congress will retain necessary access to ensure that the NIF is not being used for the development of new nuclear weapon types.

(3) Unilateral Openness Measures at NIF:

In planning for NIF operations and experiments, the Department of Energy is considering unilateral openness measures that would help avoid misperceptions about NIF's purposes, capabilities and activities. The goal of these measures is to reassure both the U.S. public and other nations that the NIF is not being used to develop new types of nuclear weapons and to build public confidence that research undertaken there is not contributing to proliferation.

Specific measures relating to classified experiments will also be valuable. Possible measures might include:

- Public discussion of the technical capabilities of NIF and types of nuclear weapons information that can be obtained from NIF experiments generally;
- A published roster of planned unclassified and classified experiments;

- Review of classified research by outside scientific and policy experts; and
- Release of certain information about the purposes of some experiments.

International collaboration at NIF on unclassified experiments means that the NIF will be populated by non-cleared and non-U.S. scientists much of the time. It would seem implausible that the United States would choose such an open facility at which to develop innovative new nuclear weapons. This will go far to enhance openness and transparency at NIF as well as build confidence internationally that the NIF is being used for the stated Stockpile Stewardship purposes and that work at NIF is of high scientific value.

The need for openness measures at NIF will need to be balanced against the competing need to protect sensitive information about classified experiments which would be of value to potential proliferators.

D. HORIZONTAL PROLIFERATION

Technical Factors That Mitigate Utility of ICF for Proliferation:

There are a number of technical factors that make it difficult for proliferators to apply information openly available through publication of data from any ICF facility directly to the development of nuclear weapons:

- ICF technology lacks basic relevance for a first generation fission device.

- An ICF capsule is not a nuclear weapon secondary and ignition and burn in ICF capsules proceed quite differently from that in thermonuclear secondaries. Strategic thermonuclear secondaries having very large yields operate very differently than ICF capsules.

- ICF capsules are extremely sensitive to details in the path to ignition. The energy generated by a nuclear weapon primary which is available to implode the secondary is approximately 100,000 times the energy required for ICF capsules. Also, ignition in ICF capsules proceeds differently than ignition of the boost gas in primaries. Thus, information on ICF capsule ignition adds little that is useful for weapons design by a proliferator.

- Although conditions of energy density anticipated for NIF and some foreign facilities are closer to those in nuclear weapon explosions than other ICF facilities, the energy involved is still many orders of magnitude less, i.e., factors of one millionth to one ten-millionth. Also, the volume to be studied at the NIF is one millionth to one ten-millionth the volume of a thermonuclear secondary. Extrapolating the results from a "microscopic" experiment to the size of a full-scale nuclear device without past nuclear test data is extremely difficult. Even for the nuclear weapon states with access to nuclear test data, such extrapolation is not straightforward.

- Because of the large difference in scale and method of ignition between an ICF capsule and a nuclear weapon, mix models developed for ICF capsules may be inappropriate for nuclear weapons. It can never be clear from laboratory ICF research alone just what mix modeling and information is relevant or applicable to nuclear weapons design. To make that connection, it would be necessary to have mix data from nuclear weapon tests.

- Although experimental data on light weight materials at NIF could be used indirectly to improve some opacity codes for heavier materials, these data are far less useful than detailed spectral information on heavier materials which would remain classified.

Factors such as the small size of an ICF capsule and differences in how secondaries and ICF capsules ignite make unclassified ICF research not directly useful for potential proliferators. Utility of ICF data would be greatly enhanced if the proliferator already possessed sophisticated computer codes and access to data from past nuclear tests. Furthermore, it should be noted that

scientists in other high energy density fields such as astrophysics and plasma physics, who have a need for high energy density calculations, are beginning to publish openly, both in the United States and in other countries, information of the type that NIF will produce. Therefore, the most important technical means of preventing nuclear proliferation relate more directly to nuclear weapons, such as controlling production of fissile material, preventing the spread of classified information about nuclear weapons design and nuclear weapon test data, prohibiting nuclear weapon testing, and preventing espionage.

Proliferation by Other States:

Proliferation by other countries as a result of access to ICF or unclassified NIF data is best examined according to the level of a country's capability in the area of nuclear technology. The categories below reflect the nuclear weapon development path taken by the United States. It is likely, but not guaranteed, that proliferators would follow a similar path. If proliferators followed a different path, these categories are still useful as indicators of technical sophistication. Some states may attempt to preserve the option to "break-out" of non-nuclear weapon state status by, among other actions, acquiring large amounts of fissile material through reprocessing and maintaining a cadre of scientists who understand the physics that relate to nuclear weapon secondaries and some aspects of boosted primaries under the guise of working on a legitimate peaceful nuclear activity such as ICF. Some have termed this phenomenon "latent proliferation". Hence, the categories listed below relate to a state's capability to develop a certain type of nuclear weapon technology, rather than necessarily already possessing such weapons. The term 'proliferator' would imply that a country has a willful intent to use a given capability to develop nuclear weapons or has already done so. States may be divided into four categories, according to the level of a country's nuclear-technological capability:

1. Entry-level proliferators that seek the capability to develop simple, unboosted fission devices, or to actually develop such weapons;

2. Second-level proliferators who possess the capability to develop simple fission devices, or who actually possess such weapons, and who may seek the capability to reduce fissile material use and improve weapon yield and delivery capability, possibly by means of boosting;

3. Advanced proliferators with the capability to design and field boosted or unboosted primaries, or who already possess such weapons, and who seek the capability to develop thermonuclear weapons or to improve them; and

4. Declared nuclear weapon states with the capability to (a) conceive, design, and produce thermonuclear weapons with state-of-the-art yield-to-weight ratios and (b) conceive and design nuclear explosives for directed-energy or other advanced weapon purposes.

What follows is an analysis of the potential utility of ICF data to each category of proliferator:

Value of ICF to Category One Countries

In seeking to develop simple, unboosted fission devices, entry-level proliferators in Category One would have to be able to assemble adequate fissile material into a critical mass. This could be accomplished by using propellants to drive one sub-critical mass into another sub-critical mass (gun assembled device) or by using high explosives to compress the material (implosion device).

Most of the information associated with development of simple fission devices is understood at levels significantly more sophisticated than the estimates used in the 1940s. Such information is readily available in the open literature and is widely disseminated. A state in a pre-Category One or Category One status would optimize the investment of its resources in improved hydrodynamics associated with high explosives and fissile material compression and an improved capability to produce neutron generators. These issues are unrelated to NIF and ICF.

If a Category One proliferator conducted ICF experiments using heavy metals such as depleted uranium, he could gain limited data that might help him evaluate radiation transport and opacity codes and improve his calculations of the explosion phase. However, these improvements would have a very minor impact on the performance of his weapons.

Thus, ICF technology lacks basic relevance for developing a first generation fission device, the simplest and most common route for proliferation. A Category One proliferator would find NIF to be of virtually no value. Other factors are of greater importance in providing what would be required to become a Category One proliferator, or to move to Category Two.

Value of ICF to Category Two Countries

A Category Two state possesses the capability to develop a simple single-stage device, or has already done so, and would seek devices with higher yield-to-weight ratios and more efficient utilization of fissile material. A longer-range plan to develop thermonuclear secondaries would lead such a state to consider how to improve the properties of its primaries by producing more yield in smaller masses of material. Boosting provides a way to achieve these goals, but requires the proliferator to possess more advanced technological skills than required for development of a simple fission device.

The U.S. moved very quickly into boosted primary designs by nuclear testing in the early 1950s using technology considered rudimentary today. The current state of available knowledge and available computers and computer codes is considerably better than in the 1950s.

APPENDIX II:

NEW DOE ICF CLASSIFICATION GUIDANCE FOR NIF

Key changes in the new classification guidance that impact research at NIF are:

- All information, experimental and calculational, for laboratory capsules that absorb an amount of energy less than or equal to 10 MJ and whose maximum dimension is less than or equal to 1 cm is unclassified (with some exceptions). Information pertaining to all other laboratory capsules is classified.

- All information pertaining to laboratory ICF hohlraums that reach a peak temperature of 400 eV (electron Volts) or less, either by calculation or experiment, are unclassified (with some exceptions). 400 eV is equivalent to 4.7 million °C.

- Calculations, modeling, and experimental data on hydrodynamic instabilities and mix in unclassified ICF targets are unclassified (that would not reveal other classified information). The association with, applicability to, or actual use of mix data or mix models in nuclear weapons design remains classified.

- All information relevant to the energy applications of ICF, consistent with classification restrictions on targets and hohlraums, is unclassified, except for results of classified codes. For unclassified targets this would include time dependent output spectra of neutrons, gamma rays, x-rays (with some restrictions), fuel atoms, reaction products, and target debris..

- ICF fabrication techniques are unclassified unless they reveal classified target design information or a specific classified weapon design, experiment, or fabrication method.

Classification policy pertaining to all ICF research that remains unchanged is:

- Target designs that are tailored specifically for weapons or weapons-effects applications remain classified. Output information for targets that have been tailored for weapons effects applications remains classified.

- All information for indirect-drive capsules for which the peak radiation drive temperature is greater than 400 eV remains classified.

- Capsules containing fissile material and certain classified concepts remain classified.

- Calculations or measurements for ICF capsules where classified equation of state or opacity information would be revealed remain classified.

- The results of classified computer codes for ICF capsules remain classified, except for certain time- and spatially-integrated quantities such as yield, gain, neutron, and x-ray output.

- The results of classified computer codes for hydrodynamic instabilities and mix in convergent geometries remain classified.

Given the above discussion on classification, the following list is exemplary of unclassified research that could be conducted at NIF:

- Research on DT ignition and burn in ICF capsules up to 1 cm diameter. This is significantly greater than the baseline capsule size designed for the NIF. Significantly larger capsules would require greater energy absorption than NIF could provide. However, capsules intended to address specific nuclear weapon design issues, simulate nuclear weapon outputs, or address specific weapon physics issues would be classified.

- Research on opacities at temperatures less than or equal to 400 eV. However, opacity information particularly applicable to nuclear weapons would remain classified, *i.e.*, for certain materials above certain temperatures and certain spectrally resolved opacity information. Results from calculations that would reveal classified opacity data, and laboratory data, experiments, or designs aimed at obtaining information on weapons physics remain classified.

- Research on hydrodynamic instabilities and mix. However, the association with, applicability to, or actual use of mix data or mix models in nuclear weapons design remains classified.

- Equation of State research. However, measurements or calculations for this research could not reveal classified equation of state information.

- Research on atomic emission and absorption of high-energy-density plasmas. However, spectral data for certain elements, under certain conditions must remain classified, as must certain spectrally resolved opacity measurements.

- Research on the transport of radiation. However, research for clarifying radiation transport issues related specifically to weapons remains classified.

- Research in developing radiation sources or using such sources for other purposes. However, output information for targets that have been tailored for weapons effects applications remains classified.

APPENDIX III:

COMPENDIUM OF PUBLIC COMMENT AND DEPARTMENTAL RESPONSES

The public comments summarized in this appendix were made at public meetings held on the outline for the study, as well as meetings on the draft study itself. This section also summarizes written comments received following meetings on the outline as well as meetings on the draft study. Written comments were received by the Department until October 11, 1995. Five public meetings were held in connection with this study: three public meetings on the outline for the study (January 24, 1995 in Oakland, CA; January 30, 1995 in Washington, DC; and March 9-10, 1995 in Livermore, CA) and two public meetings on the draft study (September 21, 1995 in Washington, DC; and September 28, 1995 in Livermore, CA).

The format of this section is as follows:

(#) **Generalized Public Comment (in bold)**

"Sample public comment supporting above" (Last name of commenter, PM/WC #, page #.)

"Sample public comment supporting above" (Last name of commenter, PM/WC #, page #.)

The Department of Energy response to public comment will be presented in bold in a text box. In some cases, the report has been amended according to public comment and the amended section or sections will be referenced in this box.

Public Comment Reference Key: (For public meetings, page of transcript will be cited. For written comments, page of quote will be cited.)

Type and Place of Meeting:	Date:	Code:
Public Meeting on Study Outline, Oakland, CA	1/24/95	PM1
Public Meeting on Study Outline, Washington, DC	1/30/95	PM2
Public Meeting on Study Outline, Livermore, CA	3/9-10/95, Vol. I	PM3
Public Meeting on Study Outline, Livermore, CA	3/9-10/95, Vol. II	PM4
Written Comments on Study Outline		WC1
Public Meeting on Draft Study, Washington, DC	9/21/95	PM5
Public Meeting on Draft Study, Livermore, CA	9/28/95, Morning Session	PM6
Public Meeting on Draft Study, Livermore, CA	9/28/95, Evening Session	PM7
Written Comments on Draft Study	Due Date: 10/11/1995	WC2

COMMENTS ON NIF AND STOCKPILE STEWARDSHIP:

(1) The value of NIF in the U.S. Stockpile Stewardship and Management program is not analyzed:

"Primary objectives of NIF for stockpile stewardship not fully explained." (Cochran, WC2, p. 1)

The report should weigh the value of NIF for maintaining the safety and reliability of the stockpile against its proliferation implications.(Larkin, WC2, p. 9)

"The NIF is not needed to maintain the existing arsenal under safe conditions as it awaits dismantlement." (M. Kelley, PM3, p. 59)

"If the question is what are the nonproliferation aspects of the NIF, they are negative, they are damaging, quite seriously, by the example, as many people have said. If the question at hand is, we have either the NIF or nuclear explosions, I think nuclear explosions would be more damaging than the NIF... If the question is, is the NIF a necessary price... to prevent nuclear explosions? You need to demonstrate that it's both necessary and sufficient." (Anderson, PM7, p. 172-4)

"The study should articulate a statement of purpose and need...Most importantly, the alleged contribution of NIF to ensuring the 'safety' and 'reliability' of the existing arsenal must be carefully examined." (Western States Legal Foundation, WC2, p. ii)

"I also think they [experiments at NIF] will not contribute to stockpile safety or understanding of the safety questions, such as corrosion, oxidation reduction and water problems. Those are all material problems." (Fulk, PM3, p. 102)

"The study should contain a genuine discussion of alternatives. To avoid turning the Study into a rationalization of a choice already made, and to inform the public and decision makers about the true choices concerning NIF and other facilities, the Study should encompass a range of potential and stockpile and policy requirements, examining the need for NIF and other facilities and their proliferation impacts in each case... DOE will need to examine a range of timelines for reduction toward and achievement of zero [nuclear weapons], with their associated facilities and impacts." (Western States Legal Foundation, WC2, p. ii and 21)

"Unless many of our top weapons designers and policy makers have been misleading us in the past, those weapons can be maintained in a safe and reliable state for the foreseeable future using technology and equipment which already exists." (Western States Legal Foundation, WC1, p. 4)

"The draft study should: provide an honest and fair analysis of how NIF is or is not needed for stockpile 'safety and reliability'... cease claiming that the[Stockpile Stewardship and Management] program doesn't include weapons design and development." (Larkin, WC2, p. 7)

"I find this to be an extremely interesting report because, in part, it seems to me to be a fairly objective evaluation of at least some -- not all, but some of both the vertical and horizontal proliferation impacts of the National Ignition Facility, and I congratulate you on that... it also demonstrates what I might call a political defense of NIF, and I believe that the conclusions of the report, that we should go ahead with NIF, fundamentally do not follow from the information that is presented in the report." (Burroughs, PM7, p. 144)

"Unless discussion includes the question of whether nuclear weapons development is really needed, the hearings, the ultimate report on the NIF, and the DOE itself, will be viewed as a facade for the protection of work on nuclear weapons without benefit of the views of those among the public who differ." (Pilisuk, WC2, p. 3 and WC1, p. 4)

"I believe that curatorship... should be considered as a serious alternative to stewardship..." (Katz, WC2, p.5)

This study does not attempt to judge the value of the National Ignition Facility (NIF) for stated U.S. Stockpile Stewardship objectives, but instead analyzes the vertical and horizontal proliferation implications of NIF. The contribution of NIF towards U.S. Stockpile Stewardship goals has been described in the DOE/Defense Programs report, "The Stockpile Stewardship and Management Program" (May, 1995) and will be further delineated in the Programmatic Environmental Impact Statement (PEIS) process.

(2) The proliferation implications, both vertical and horizontal, of all U.S. Stockpile Stewardship Facilities put together, should be analyzed in this report. This report, on its own, is not sufficient.

"The proliferation impact review fails to consider how the National Ignition Facility could be used for nuclear weapons research in combination with other existing and proposed 'Stockpile Stewardship' facilities . . ." (Western States Legal Foundation, WC2, p. 4; also B. Brown, WC1, p. 1; Cabasso, PM4, p. 8; Eldredge, PM2, p. 19-20, PM5, p. 54-55, p. 77, WC2, p. 1; Ericson, PM7, p. 5; Erickson, PM3, p. 162; M. Kelley, PM3, p. 63; Lichterman, PM3, p. 189-190; Mello, WC1, p. 5, Taylor, WC2, p. 3; Zerriffi, PM5, p. 74)

"It simply makes no sense to consider the proliferation impacts of the NIF in isolation. Other nations will not do so in evaluating U.S. intentions." (Western States Legal Foundation, WC1, p. 2)

The PEIS is a poor forum in which to consider the nonproliferation concerns of the entire Stockpile Stewardship Management Program. (Eldredge, PM5, p. 55-56)

"The DOE should not go forward with this proliferation impact study in its current form, but rather should fold it into a broader proliferation impact review which addresses the entire [Stockpile Stewardship and Management] program. In any case, DOE should not make a decision to proceed with NIF pending completion of a programmatic review. If DOE insists on completing a NIF-specific proliferation impact analysis, this review should at minimum provide a kind of 'cumulative impacts analysis.' This would require at least a general assessment of the vertical and horizontal proliferation effects of the NIF in combination with the entire range of stockpile stewardship initiatives, including the impact on the world proliferation climate of an increasingly sophisticated U.S. nuclear test simulation capability." (Western States Legal Foundation, WC2, p. I and 8)

Although this study does not analyze the proliferation implications of each of the other proposed Stockpile Stewardship facilities separately, this study does consider the nonproliferation implications associated with NIF in the context of all proposed Stockpile Stewardship and Management (SSM) facilities. The study, in considering the contribution of NIF experiments to whether the United States could design, develop and place into the stockpile, with confidence, new types of nuclear weapons, assumed that information from all of the other elements of the U.S. stewardship program would also be available. Furthermore, NIF is the only Stockpile Stewardship facility which will be open to international visitors for basic scientific research, and thereby warrants special consideration.

(3) NIF, together with the rest of the U.S. Stockpile Stewardship facilities, will allow the United States to develop and place into the stockpile new nuclear weapons.

"NIF, together with other laboratory facilities... will give the U.S. the means to replace underground testing of nuclear weapons with very sophisticated above-ground facilities. These facilities will enable the U.S. to continue research, development, testing and engineering of new nuclear weapons." (Rauch, WC2, p. 1; also Cabasso, PM2, p. 39-40, PM4, p. 12; Erickson, PM3, p. 160; Fulk, PM3, p. 103; Hedgepeth, PM2, p. 17; Lichterman, PM3, p. 187-188; Zimmer, PM2, p. 45-46)

"So I think stockpile stewardship has become a euphemism; what it means is keeping the weapons team together, what it means is designing new weapons." (Olin, PM3, p. 22)

"The knowledge gained with NIF is probably sufficient for new weapon designs, but insufficient for stewardship, which requires simulation capabilities with much higher precision in order to determine the effects of small variations due to aging. In other words, it is impossible to have stewardship accuracy without having new design capabilities." (Hagen, WC2, p. 2)

The DOE and Labs say that " 'part of our mission of stockpile stewardship is to keep the scientists trained, keep them up to speed, and keep them interested in their work. So to do that, we have to let them go on advancing weapons science and working on nuclear arms development because otherwise they'll get bored. This is a classic case of resistance to a change in mission.... In other words, stockpile stewardship then includes weapons development, weapons R&D." (Larkin, PM7, p. 109-110)

To assure that the U.S. nuclear deterrent remains unquestioned under a test ban, President Clinton has directed the Department of Energy to preserve a core technical and intellectual competency in nuclear weapons. This core competency will be used to analyze and judge the continuing reliability and safety of the remaining U.S. nuclear weapons. These same intellectual competencies could be used to design new weapons, but most U.S. nuclear weapons experts agree that new types of nuclear weapons could not be placed into the stockpile with a tolerable level of confidence without nuclear testing. Furthermore, with regard to the NIF, the Secretary of Energy has committed to operating the NIF in the most open manner possible consistent with our nonproliferation objectives to assure the public and the international community that NIF is not being used to develop new types of nuclear weapons.

(4) Too many modifications to remaining U.S. nuclear weapons through use of the Stockpile Stewardship facilities could lead to less confidence in our weapons.

"The day may come when the laboratories say, hey, you know, we fooled around with these weapons. We have these fancy new Stockpile Stewardship Facilities. We have fooled around with these weapons, and now ... we just really can't certify their safety and reliability anymore, and the present circumstances have changed, and therefore, we better exercise Safeguard F and go back to nuclear testing. So I would offer the reverse argument, that a very aggressive Stockpile Stewardship program can be detrimental to maintenance of a comprehensive test ban treaty." (Burroughs, PM7, p. 152)

President Clinton has directed the Departments of Energy and Defense to maintain a safe and reliable nuclear stockpile in the absence of nuclear testing. Meeting our stockpile stewardship and management responsibilities in an era without nuclear testing and without new weapons development will require a new approach. This approach will rely on scientific understanding and expert judgment, not nuclear testing and development of new weapons, to predict, identify, and correct problems affecting the safety and reliability of the stockpile. Through greater scientific understanding and preservation of a core technical and intellectual competency in nuclear weapons, we seek to <u>prevent</u> the need for future U.S. nuclear testing. We have confidence that we will be able to successfully meet this new challenge using the new facilities and enhanced capabilities outlined in the Stockpile Stewardship and Management Program.

NIF's IMPACT ON THE COMPREHENSIVE TEST BAN TREATY (CTBT):

(5) The report claims that NIF facilitates U.S. adherence to a CTBT. This is a political deal, and should be judged as such.

"I don't think that's an up-front, straightforward way to talk about this political deal. This makes it sound as if, [if] NIF works,...it is going to help somehow with the CTBT... You have to be careful that the deal you're making doesn't have the seeds of even greater dangers and greater problems, and I don't see anything in this report that addresses that possibility." (Larkin, PM7, p. 159-160)

"It is sometimes said in Washington, D.C., if you want to get a Comprehensive Test Ban Treaty, you must allow the DOE to go ahead with its Stockpile Stewardship Program, including NIF. We reject that trade-off." (Burroughs, PM3, p. 50)

"So the fact that a political deal has been struck is alleged to be necessary to the achievement of a CTBT in this country is offered as a reason for why we should go ahead with NIF, there is a circularity in this . . ." (Burroughs, PM7, p. 149)

In announcing U.S. support for initiation of Comprehensive Test Ban Treaty negotiations on July 3, 1993, President Clinton stated, "To assure that our nuclear deterrent remains unquestioned under a test ban, we will explore other means of maintaining our confidence in the safety, the reliability, and the performance of our own weapons." In response, the Department of Energy and its National Laboratories developed the Stockpile Stewardship and Management program. To advance the goal of concluding a Comprehensive Test Ban Treaty at the earliest possible date and to secure the strongest possible treaty, President Clinton announced support for a "zero" yield treaty on August 11, 1995. In making this announcement, the President also established the "concrete, specific safeguards that define the conditions under which the United States can enter into a CTBT". Of the six safeguards outlined, the first two relate to the Stockpile Stewardship program:

"A) Conduct of a Science-Based Stockpile Stewardship program to ensure a high level of confidence in the safety and reliability of nuclear weapons in the active stockpile, including the conduct of a broad range of effective and continuing experimental programs.

B) Maintenance of modern nuclear laboratory facilities and programs in theoretical and exploratory nuclear technology which will attract, retain and ensure the continued application of our human scientific resources to those programs on which continued progress in nuclear technology depends".

Rather than a political deal, this is Presidential policy guidance that the Department of Energy is required to implement in order to fulfill the conditions the President requires for the United States to enter into a CTBT.

(6) NIF will undermine the Comprehensive Test Ban Treaty.

"If the DOE can go ahead with designing more nuclear weapons using the NIF facility and other components of the Stockpile Stewardship Program, this will amount to circumventing the Comprehensive Test Ban Treaty, and it will be regarded by other states in the world as not complying with Article VI [of the NPT]..." (Burroughs, PM3, p. 50; also Erickson, PM3, p. 160; Mello, WC1, p. 6)

"The NIF, and its companion AGEX programs, make a sham of any test ban by performing an end-run around the letter of a 'ban' while completely violating its spirit." (Robbins, WC1; p. 2; also Mr. and Mrs. Cox, WC1, p.1)

"NIF could be perceived by others [countries] as a design facility and, therefore, reduce confidence in the CTB." (Zerriffi, PM5, p. 71)

"The test ban is not an end in itself, but a tangible measure of restraint by the nuclear weapon states and an indication of their decreasing emphasis on nuclear weapons. Thus, the value of a CTB would be greatly diminished if functions that until now have been served by nuclear testing were largely or entirely transferred to a new environment -- the NIF." (Nuclear Control Institute, WC2, p. 2)

The CTBT "is a matter of long-term world objectives such as the delegitimation of nuclear weapons. Those objectives would be significantly compromised by 'safeguards' like NIF, just as they were compromised by 'safeguards' in 1963."(Anderson, WC2, p. 7,)

The Comprehensive Test Ban Treaty (CTBT) will impede the development of new nuclear weapons by preventing nuclear testing. NIF cannot subvert that purpose, and thereby U.S. use of NIF, in maintaining its nuclear stockpile without new weapons development or production, should not undermine confidence in a CTBT. Furthermore, any move to ban inertial confinement fusion (ICF) activities under a CTBT will likely be opposed not only by the other nuclear weapon states, but also by several other advanced industrialized nations participating in the negotiations because they have established ICF programs for peaceful purposes. Consistent with its 1975 statement at the first Nuclear Nonproliferation Treaty (NPT) Review Conference, the United States does not consider inertial confinement fusion to be a nuclear explosive device under the meaning of the NPT, and accordingly any nuclear energy release from experiments at the NIF should not be considered a "nuclear explosion" of any yield under the CTBT.

(7) There is inadequate discussion of the nonproliferation aspects of the Comprehensive Test Ban Treaty that bans all nuclear explosions of all nuclear yields, except for inertial confinement fusion explosions in the NIF facilities, on which no upper limit of explosive yield is set.

"How is inertial confinement fusion technically defined? Is it defined by its stated purpose -- e.g. for peaceful, not military purposes? If so, how is the purpose to be internationally verified? ... Is ignition with the assistance of a small explosion of fissionable material to be allowed under a CTBT? Would substitution of some type of relatively small explosively driven device for the huge pulsed laser system now envisioned in NIF be allowed,

with no limit on yield? How do answers to such questions affect prospects for horizontal or vertical proliferation?" (Taylor, WC2, p. 1)

On August 11, 1995, President Clinton elaborated that the United States is pursuing a zero-yield test ban treaty. Consistent with its 1975 statement at the first Nuclear Nonproliferation Treaty (NPT) Review Conference, the United States does not consider inertial confinement fusion to be a nuclear explosive device under the meaning of the NPT, and accordingly any nuclear energy release from experiments at the NIF should not be considered a "nuclear explosion" of any yield under the CTBT.

NIF'S IMPACT ON THE NUCLEAR NONPROLIFERATION TREATY (NPT):

(8) U.S. construction of NIF is inconsistent with U.S. obligation to achieve nuclear disarmament under Article VI of the Nuclear Nonproliferation Treaty.

". . . the maintenance of designers and design capabilities for the long term are clearly inconsistent with U.S. obligations under Article VI of the NPT recently reaffirmed at the NPT Extension Conference." (Zerriffi, PM5, p. 71-72)

"In conclusion, I will read a quote from Mexican Ambassador Miguel Marin Bosch, who was the chairman of the CTBT negotiations last year...'The overall impression that the nuclear weapon states give is that of business as usual. The cold war may be over, and, yes, the strategic nuclear competition between the Russian Federation and the United States shows signs of abating, but the relationship of the nuclear weapon states to their own nuclear weapons has not registered the kind of basic change that one might expect. They continue to rely on nuclear weapons and do not seem prepared to given them up for the foreseeable future. Quite the contrary, they are looking for ways to freeze the NPT's dichotomy between the nuclear have's and the nuclear have-nots. This does not bode well for the NPT or nuclear nonproliferation in general.'" (Cabasso, PM7, p. 131-2)

"Within this kind of an abolition [of nuclear weapons] framework, there is no role for the National Ignition Facility." (Cabasso, PM7, p. 195-196)

"If NIF is maintaining a cadre of nuclear weapons scientists,... [NIF] maintains the ability of the U.S. to vertically proliferate if we so choose to do so." (Eldredge, PM5, p. 61; also Horner, PM5, p. 93; Rogers, PM3, p. 220-221, WC1, p. 1; Zerriffi, PM5, p. 74)

"The definition of 'stockpile stewardship' has been expanded to encompass weapons design work and the full range of 'weapons science' research contemplated for NIF. It is, therefore, misleading and intellectually dishonest to say that NIF is necessary for stockpile stewardship and not weapons development..." (Larkin, WC2, p. 7)

"If NIF and other components of the stockpile stewardship program contribute to the ability of the United States to go ahead with a policy of threatening first use against non-nuclear states, it again will be absolutely incompatible with Article VI of the Nonproliferation Treaty..." (John Burroughs, PM3, p. 52)

"Missing from this [the draft study's] list[of "the most important means of preventing proliferation"] is perhaps the most important means of them all: preventing nuclear weapons research and development." (Larkin, WC2, p. 13)

At the 1995 Nuclear Nonproliferation Treaty Extension Conference, NPT parties agreed that the ultimate goal of the international community is nuclear disarmament. Of the three primary "Disarmament Principles" agreed to by all parties at the NPT Extension Conference, the first deadline that needs to be met is conclusion of a Comprehensive Test Ban Treaty by 1996. The United States is committed to concluding these negotiations at the earliest possible date. However, key to U.S. willingness to negotiate a CTBT rapidly and to live under a zero-yield treaty is its ability to exercise a nuclear stockpile stewardship program, as outlined by the President on August 11, 1995. NIF is an important component of this program to maintain confidence in the stockpile. If confidence can be maintained through stewardship instead of nuclear testing, then the nuclear weapon states may be more likely to reduce numbers of weapons than if they did not have such confidence, in the absence of testing. NIF thereby contributes positively to U.S. arms control and nonproliferation policy goals by allowing the U.S. to sign and abide by a zero-yield CTBT and by providing the U.S. continued confidence in its weapons to allow for further reductions and meet its Article VI obligations.

(9) Sharing NIF or other stockpile stewardship techniques with other countries including the other nuclear weapon states, is a violation by the United States of Article I of the Nuclear Nonproliferation Treaty.

The "NIF Report fails to adequately address whether collaboration on NIF will violate [Article I of] the Nuclear Non-Proliferation Treaty. If an undeclared objective of a non-nuclear weapon state's collaboration with the United States on ICF research is to retain a quick thermonuclear weapon design capability, is the U.S. 'assisting... a non-nuclear weapon state to acquire nuclear weapons...?'" (Cochran, WC2, p. 3)

Collaboration among the nuclear weapons states should be considered proliferation. (Kelley, PM6, p. 23)

"Speaking of NPT violations, it's becoming more and more apparent that the nuclear weapon states...have been sharing nuclear weapons information, which they are not supposed to be sharing under other articles of the NPT." (Cabasso, PM7, p. 193-194)

"The obvious question is if the NIF is going to be part of an expanded cooperative program with France, it would seem that NIF is contributing to the vertical proliferation of the nuclear weapon program in France." (Kimball, PM5, p. 21-22)

"The draft states as follows (p.35) 'The United States could encourage the other nuclear weapon states to seek to prevent the purposeful development of advanced weapon concepts at their NIF facilities under a test ban regime.' However, my impression is that the U.S. will not follow up this concept." (Anderson, WC2, p. 5-6)

"What assurance can be given that the French (or U.K.) experiments on NIF, or experiments on a French NIF-like facility built with U.S. support, will not be conducted for weapon development, as opposed to insuring reliability of the existing arsenal?" (Cochran, WC2, p.2)

"Our cooperation with France is clearly vertical proliferation" (Nurmela, WC2, p.1)

Article I of the Nuclear Nonproliferation Treaty (NPT) prohibits nuclear weapon states from transferring nuclear weapons or nuclear explosive devices or control over such weapons or devices to any state. The sharing of classified information derived from the NIF among the nuclear weapon states is not a violation of Article I of the NPT. The United States has classified collaborations with the British under the U.S.-U.K. Mutual Defense Agreement of 1958 and it is likely that the British and Americans will cooperate on weapon-related research at the NIF. At present, collaboration with France on NIF and on ICF is unclassified. A current U.S.-French joint project concerns the design of each of our large laser facilities. Article I of the NPT also prohibits nuclear weapon states from assisting in any way, encouraging, or inducing any non-nuclear weapon state to manufacture or otherwise acquire nuclear weapons or other nuclear explosive devices, or control over such weapons or devices. With regard to U.S. collaboration with other nations on inertial confinement fusion technologies, these collaborations are also completely unclassified. Inertial confinement fusion has not been considered to be a nuclear explosive device under the meaning of the NPT and a number of non-nuclear weapon state parties to the NPT have ICF programs for peaceful purposes. Unclassified collaboration on ICF with any state is not a violation of Article I of the NPT.

(10) Comments take issue with Report claim that no nation has objected to U.S. understanding that ICF is not a nuclear explosive device under the meaning of the Nuclear Nonproliferation Treaty.

"In stating that no nation has objected to the U.S. statement [defining ICF as distinct from a nuclear explosion] at the NPT Review Conference in 1975 at the time or since (p.32), the Draft NIF Report is simply wrong. The scope language tabled by India in June 1995, (CD/NTB/WP.244) would prohibit ICF experiments on NIF..." (Cochran, WC2, p. 3)

The above comment confuses two separate negotiations. In discussing the relation of ICF to the NPT, the draft study asserted that, "No nation objected to this statement [U.S. 1975 Statement at NPT Review Conference on ICF] regarding ICF and the NPT at that time, nor since." During Comprehensive Test Ban Treaty negotiations in Geneva earlier this year, India proposed treaty text which would effectively ban ICF under a CTBT. However, India is not a party to the NPT and the Department has been unable to confirm whether any Indian officials have made statements asserting that ICF should be considered a nuclear explosive device within the meaning of the NPT. To avoid future misunderstanding, this has been clarified in the final draft to state that "No NPT party objected to this statement regarding ICF and the NPT at the time nor since, although some NPT parties have proposed Comprehensive Test Ban Treaty (CTBT) language that could be considered to cover ICF as a prohibited activity under a CTBT."(see page 35 of study).

IMPACT ON REGIONAL PROLIFERATION MOTIVATIONS:

(11) U.S. commitment to the National Ignition Facility sends a negative signal to the rest of the world about U.S. efforts to achieve nuclear disarmament.

"If we opt to go ahead with this project [NIF], we send a clear signal to other nations of our intention to continue feeding the forces which generate proliferation and nuclear terror for all the peoples of the world." (Rogers, PM3, p. 224)

"I would urge the Administration to think about whether whatever the perceived benefits there are in going forward with the NIF can outweigh the very ambiguous signal that that sends." (Horner, PM5, p. 93)

"The bottom line, what I'm saying about this report is it misses the point... What is the message that a U.S. investment of billions of dollars, a whole slew of new technologies to maintain its nuclear competence sends to the rest of the world?" (Cabasso, PM7, p. 131)

NIF may be seen as a threat by those who distrust the United States and encourage proliferation. (Larkin, PM3, p. 88, WC1, p. 4; Nesbitt, PM3, p. 99-100; Olney, WC2, p. 2)

"The NIF will be viewed by other countries, and especially by potential proliferators, as a very large, expensive commitment to nuclear weapons, and to the eventual possibility of new types of weapons, even though such new types would not rapidly go into the detailed-design phase." (Anderson, WC2, p. 2, also PM3, p. 196-197)

"It would be helpful if your study explored how the non-nuclear nations' attitudes of distrust and suspiciousness, engendered by U.S. policy, will jeopardize efforts to prevent proliferation." (Smick, WC1, p. 1)

The construction of NIF displays a continued U.S. commitment to nuclear weapons that may undermine nonproliferation and disarmament efforts. (Adle, WC2, p. 1; Cabasso, PM2, p. 40; Caseber, WC2, p. 1; Ebersole, WC1, p. 1; Erickson, PM3, p. 161-162, PM7, p. 104; Dr. and Mrs. Fischer, WC1, p. 1; B. Fischer, WC2, p. 1; Frisch, PM3, p. 209; Gould, PM3, p. 155-157; Johnson, PM2, p. 51; Larsen-Beville, PM3, p. 66; Laub and Nurmela, WC1, p. 1; McClintic, WC2, p. 1; Miles, PM3, p. 80-82; Olney, PM4, p. 33, WC2, p. 1; Robbins, WC1, p. 2; Smick, WC1, p. 1; Vance, WC2, p. 1; Zimmer, PM2, p. 48).

"While demanding that other nations abandon their nuclear aspirations, the U.S. is continuing to legitimize nuclear weapons as an instrument of national policy and is imposing an international double standard in an increasingly uncertain world." (Western States Legal Foundation, WC1, p. 1-2; also Robbins, WC1, p. 2)

"[The report] asserts that NIF will have no effect on regional motivations [to develop nuclear weapons], but I wanted to suggest that legitimacy of nuclear weapons as an instrument of policy is a key element to justifying and reinforcing any motivations for acquiring nuclear weapons" (Ericson, PM7, p. 102)

"I'm totally opposed to [NIF] being misused for military nonsense...It's a wrong message out to the world..." (Hagen, PM7, p. 168-169)

"... the perception by other nations that we are continuing to design nuclear weapons systems may speak louder than the reality and they may base their future plans regarding nuclear development on that perception." (Candell, WC2, p. 1)

"The U.S. plans for a permanent nuclear weapons establishment in this country and its uneven handling of relations with other countries are well known to the world community. The non-favored nations feel threatened and will continue to strive for their own nuclear arsenal by whatever methods are available to them, including building nuclear power plants. Our only hope for non-proliferation of nuclear weapons and true national security is an international treaty for total nuclear disarmament." (Nurmela, WC2, p.1)

"I suggest that it is better to describe the future task as curatorship than stewardship, and emphasize the distinction between these two concepts... The chief nuclear danger in the present world is that of proliferation, and stewardship will exacerbate this danger, while curatorship will mitigate it while preserving our existing nuclear forces." (Katz, WC2, p. 1)

At the April-May 1995 Nuclear Nonproliferation Treaty (NPT) Extension Conference, only a handful of NPT parties expressed concern over stockpile stewardship activities of the nuclear weapon states under a test ban treaty. In the area of arms control and disarmament, the highest priority of the non-nuclear weapon states at the Conference was obtaining a commitment from the nuclear weapon states that conclusion of Comprehensive Test Ban Treaty negotiations was imminent. NIF will contribute to U.S. ability to conduct a stockpile stewardship program which is one of the safeguards that define the conditions under which the United States can enter a CTBT.

As the study states, the history of proliferation repeatedly has shown that decisions to develop or acquire nuclear weapons have been driven by specific regional security concerns, political tensions, and/or prestige. Addressing these regional motivations will be the key to long-term success of nonproliferation. This was explicitly recognized by President Clinton as part of his Nonproliferation and Export Control Policy announced in September, 1993, which stated that progress on regional arms control and nonproliferation is inextricably linked to efforts to "address the underlying motivations for weapons acquisition." The U.S. Government, including the Department of Energy, is actively working to promote arms control and confidence-building measures in troubled regions.

COMMENTS ON OPERATION OF THE NIF:

(13) Comments on Openness Measures at NIF:

"We would like to applaud the recommendations made in this study for greater openness regarding experiments on the NIF. W e urge that this openness [regarding experiments on the NIF] apply not only to other members of the research community, but also to the general public. We also urge that this effort towards openness be institutionalized by the Department, and apply to all projects and facilities in the Science-Based Stockpile Stewardship (SBSS) program, not just the NIF." (Eldredge, WC2, p. 1)

"The countermeasures proposed in the draft report do not provide the necessary reassurance.... We urge DOE to mandate an annual report to Congress on weapons and non-weapons activities at the NIF. This report should be unclassified -- with a classified appendix, if necessary -- to ensure that members of the public can obtain information on NIF. We also recommend that DOE establish an oversight board that includes at least one member of the public-interest community." (Horner, WC2, p. 4)

"Most of the specific measures to reduce the tendency of NIF to cause proliferation lack any commitment at all, even for the length of this Administration, much less for years beyond." (Anderson, WC2, p. 4)

"The study treats proliferation as a public relations matter. In its conclusion and discussion of policy, it becomes almost solely occupied with how people can be reassured and suspicions laid to rest." (Larkin, WC2, p. 4)

"The Study should address the inadequacies of the proposed transparency measures.... The draft study states that the DOE is 'considering certain unilateral openness measures...' but admits that these measures are only being 'considered'. The Study should address the expected consequences if NIF is operated without such openness measures in place. Further, the most significant of these measures - published rosters of both unclassified and classified experiments, and outside program review of classified research -- may be very difficult to implement in a manner which imparts confidence to outside observers. The study should address how DOE will provide believable assurances that a listing of classified experiments is complete and its characterization of their nature adequately informative and explain how program reviewers will be found who have both the requisite security clearances and who can truly be considered 'outside' of the U.S. weapons establishment for purposes of imparting international confidence in U.S. intentions." (Western States Legal Foundation, WC2, p. v)

Secretary O'Leary is committed to operating the National Ignition Facility in the most open manner possible while supporting our objectives of reducing the global nuclear danger. The Department is currently developing a management plan for NIF to meet the recommendations of this report. Throughout NIF construction and operation, the Department will continue to be receptive to public concerns so that the openness plan for NIF is responsive to their needs. In addition, the study explores the proliferation consequences for NIF operation regardless of openness measures in the section of the report entitled, "What weapons science can the U.S. do on NIF".

(14) This report places too much stock on the Administration and Congress to prevent new nuclear weapons development at NIF.

There is no way to ensure that sentiments within Congress and/or the Executive branch will not change to utilize NIF in conjunction with other facilities to develop new weapons. (Eldredge, PM5, p. 80, p. 1; Olney, WC2, p. 1, Zerriffi, PM5, p. 70-71)

"To state that the present policy is not to develop nuclear weapons . . . is really not an adequate answer at all to the problem of vertical proliferation posed by the development of the National Ignition Facility." (Burroughs, PM7, p. 146)

"This means, in essence, that the United States will not allow research that encourages vertical proliferation, unless the United States decides to allow research that encourages vertical proliferation. The reporting measure cited to ensure that Congress is informed about DOE weapons and development activities, (PL 103-337), furthermore appears to call for a classified report, hardly an effective means of informing the public or the international community about actual U.S. capabilities and intentions" (Western States Legal Foundation, WC2, p. 21)

"The main problem with your Draft Study is that its nonproliferation assurances are based on the present political situation without regard for how that may change during the useful life of the NIF. Page 8 of the study states that this Administration is not planning to develop new types of nuclear weapons. But what about a future Administration? By keeping a cadre of scientists together and competent in nuclear weapons design, NIF could speed up production of nuclear weapons in the future. This constitutes Vertical Proliferation." (Dean-Freemire, WC2, p. 1)

It is important to note the technical limitations of the NIF in this context. The study describes NIF's relatively limited utility in developing some new types of nuclear weapons which would be considered to fuel vertical proliferation. (See the two sections entitled, "Approach of the Technical Analysis Section," and "What U.S. weapons scientists could do on NIF"). The study concludes that NIF could provide some input data to the design of, for example, nuclear directed energy weapons, but would fall far short of being able to proof-test those new types of weapons, even with all of the other Stockpile Stewardship facilities that the United States might have at its disposal.

Furthermore, it is expected that approximately 80% of NIF experiments will be unclassified and could involve international scientific collaboration. Thus, the NIF can be populated by non-cleared and non-U.S. scientists much of the time. This degree of openness will be difficult for the United States to reverse, even if U.S. policy changed.

In addition, the study has been amended to more fully describe the classified report to Congress required of the Nuclear Weapons Council, through the Secretary of Energy, on nuclear warhead activities. (See page 22 of study.)

(15) There is a conundrum between classification and transparency in the report. How can the facility be open and at the same time closed?

"There are many apparent self contradictions or ambiguities in the study related to the maintenance of both openness and secrecy in the NIF project operations." (Taylor, WC2, p. 3)

"On page 28, the study mentions 'increased openness'. This will make information on nuclear weapons design available to any nation wishing to develop or improve their nuclear weapons." (Dean-Freemire, WC2, p. 1)

The Department recognizes that there will be tension between openness measures at NIF and the need to keep certain information classified to prevent the spread of nuclear weapon design information to proliferant nations. However, the Department believes that workable solutions to such tension can be developed which meet the twin objectives of openness and reducing the global nuclear danger. DOE/Defense Programs is already developing a proliferation management plan to address some of these issues, and is taking public comment garnered from this process into account in developing the plan.

(16) Will fissile material be used at NIF if the Administration changes?

"The draft indicates that using fissile materials in NIF experiments would open up some areas of weapons research. However, it doesn't examine these areas because 'such experiments [using fissile material] could not be performed at the NIF as it is presently designed, and there is no intention on the part of the Department to pursue such experiments' (p.14). The draft should not be so quick to discount the possibility that this intention could change and that simple modifications to the facility would adapt it for these experiments." (Larkin, WC2, p. 10)

Appendix II of the study, which outlines the new DOE ICF classification guidance, states that research on capsules containing fissile material would remain classified. However, the draft report has been amended to state that a physical upgrade to NIF as well as further National Environmental Policy Act (NEPA) approval would be required in order to use fissile material at NIF. There currently is no intention on the part of the Department to pursue classified or unclassified research at NIF involving fissile material. It should be mentioned in this context that the use of depleted uranium is likely not to require further NEPA process, and could be conducted at NIF as it is presently designed. These latter experiments would be subject to the type of transparency measures or outside scientific program review regarding classified experiments that are proposed in the study.

COMMENTS ABOUT NIF'S PURPOSE:

(17) NIF's real purpose is to preserve the capability to design and develop new nuclear weapons.

"From the beginning, NIF has been conceived as a research facility for nuclear weapons design... The study outlines various areas of weapons research that clearly demonstrate NIF's potential for major advances in 'weapons science.' These advances will yield new weapons concepts, and consequently new weapons designs. ...". (Larkin, PM5, p. 106, WC1, p. 3, WC2, p. 2)

"We can only view the NIF as one key component of U.S. plans to maintain substantial nuclear weapons research, developments and production capabilities well into the 21st century." (Gould, PM3, p. 154-155)

"This proposed facility is obviously designed to allow continued testing of nuclear weapons and, by extension, new designs and concepts for nuclear weapons." (Igel, PM4, p. 23; also Patton, WC1, p. 1)

"... despite its claims for dual use, the facility is intended largely to continue experimentation and development of nuclear weapon capabilities." (Pilisuk, WC1, p. 2, WC2, p. 2)

"U.S. PIRG believes that the NIF will contribute little if anything to the development of a clean, affordable energy source, and thus this justification is merely a smokescreen for continuing weapons-related research." (Anna Aurilio, WC2, p. 1)

It is contradictory that approximately only 20 percent of the experiments at NIF will be classified while the facility is fully funded out of the defense budget. (Eldredge, PM5, p. 80-81)

"If there is a valid peace-time purpose for the NIF, let the UN and non-aligned nations supervise its development." (Lovuolo-Bhusan, WC1, p. 1)

"I am particularly upset with the lies that the DOE is giving to the press regarding this project. This morning's San Francisco Chronicle quotes a DOE Draft Report as saying,...'None of the experiments planned for the huge complex - not even the secret ones - could help weapons scientists design new nuclear weapons or enable other nations to develop their own.' This is contrast to the LLNL's Institutional Plan 1994-1999..." (Scott, WC2, p. 1)

"One of the major contentions, in this report and elsewhere, is that the NIF along with other advanced scientific facilities are absolutely necessary to maintain the planned stockpile in a 'safe and reliable' manner, while at the same time making the claim that they of course couldn't and wouldn't be used to design new nuclear weapons. This defies BASIC LOGIC." (Nesbitt, WC2, p. 1)

"The Policy Conclusions in the Department of Energy's Draft Study of August 23 state that the Administration is not planning to develop new types of nuclear weapons. However, according to a Livermore planning document, one of NIF's principal missions is "to provide an aboveground simulation capacity for nuclear weapon effects on strategic, tactical, and space assets..." (Nurmela, WC2, p. 1)

"Our country doesn't need the weapons programs now like it did through the early eighties. The political situation does not warrant it. The NIF is really a DOE project primarily for weapons." (Barlow, WC2, p.1)

"NIF is being "sold" as all things to all people. The local community is told it will create jobs. "Doves" in Congress and astrophysicists are told it will be a great tool for scientific research. The Defense Department and the "hawks" are told it will be used to maintain existing weapons, to help develop new weapons, and to keep a cadre of weapons designers competent should the world situation becoming more threatening to the U.S. I see the NIF as a dangerous example of pork barrel politics and am very concerned about the possibility of increasing proliferation risks." (Dean-Freemire, WC2, p.1)

As stated in the study, the U.S. Congress and the President have directed the Secretary of Energy to ensure that the stewardship program preserves the core intellectual and technical competencies of the United States in nuclear weapons without nuclear testing and without new weapons development and production. The Department has determined that NIF contributes to the mission of stockpile stewardship through supporting the examination of some of the basic physics processes involved in nuclear weapons operation and by retaining and attracting talented scientists and engineers. Although NIF could provide some input data into some new weapon type designs, its primary weapons application is for studying physics issues that relate only to maintaining the U.S. arsenal. Furthermore, nuclear testing would be needed to develop and place into the stockpile new warhead designs which we are confident are reliable. To assure the public and the international community that the NIF is not being used to develop new types of nuclear weapons, the study recommends several measures to enhance openness surrounding U.S. weapons work at NIF.

NIF AND VERTICAL PROLIFERATION:

(18) Since NIF cannot proof-test a nuclear weapon, the study ignores what NIF can do for weapons development in a more limited role.

"Repeatedly [stated] throughout the document is that since NIF cannot proof-test a nuclear weapon or nuclear device, it is somehow not a proliferation risk, and we proffer that that rationale is not sufficient.... And we ask that more weight be given to the NIF's ability to improve weapons design, and 'tweak' or modify current designs, especially in the context of other aspects of the SBSS program." (Eldredge, PM5, p. 78-79, WC2, p. 1)

"NIF...would isolate the fusion reaction and take it out of the noisy environment of a bomb blast.... The advantages are obvious. The draft study ignores these advantages.. and [concludes] NIF may not be all that useful for weapons development... It is misleading, therefore, to present NIF as a poor substitute for underground tests. It should be judged for what it is and the role it will play in the future, not for how well it substitutes for the role played by test explosions in the past." (Larkin, WC2, p. 9-10)

"A term like 'new nuclear warhead design' can have a wide ranges of meanings. At one extreme the design could be so different from existing designs as to be very difficult to develop, even with full-scale test explosions.... At the other extreme, designers should have no difficulty at all developing certain designs that are not identical to currently proof-tested designs.... Intermediate between these extremes, it appears to me that there probably is a range of warhead designs that could be developed with a NIF, but not without it. Therefore, statements that NIF cannot proof-test a design do not allow the conclusion that the NIF cannot replace proof-testing in all potentially significant situations." (Anderson, WC2, p. 8)

"Unfortunately, the report falls short in its analysis and does not resolve key questions, inconsistences, and contradictions produced by the various arguments DOE has made. For example, how important is the weapons information that the NIF would provide?" (Horner, WC2, p. 1)

"The response of the government to concerns about future weapons design activity has been that new designs cannot be deployed without full-scale nuclear testing. This however, should not be the end of the inquiry in a proliferation impact review. The review should also consider how much progress can be made towards developing weapons with new or improved military capabilities using the proposed array of simulation facilities." (Western States Legal Foundation, WC2, p. 6-7)

"The Study should give the same level of attention to the potential technical advantages of new, more sophisticated weapons test simulation techniques as it gives to the disadvantages when comparing them to full-scale nuclear testing." (Western States Legal Foundation, WC2, p. iv)

The study describes NIF's capability, in the absence of nuclear testing, to allow for meaningful, albeit small laboratory-scale, study of some of the basic physics processes involved in weapons operation, namely the fusion processes. Thus, the study does examines the type of input data that NIF could provide on some of the basic physics of advanced nuclear weapon concepts. However, while the same fusion processes would occur during NIF target ignition as in a nuclear explosion, they occur in a nuclear weapon on a much larger scale and simultaneously with other competing processes. As stated in the report, the United States, using computer codes based on decades of nuclear weapon test data, can do the necessary extrapolation to nuclear weapon size and calculate the effect of many competing processes for existing weapons in the stockpile. However, for new nuclear weapon design concepts, there would likely be no nuclear test data to compare with NIF results, and therefore, it would be extremely difficult for U.S. weapons scientists to successfully develop a new type of nuclear weapon using the NIF, even in conjunction with other stockpile stewardship facilities.

(19) The description of vertical proliferation is inconsistent in the report.

"Nowhere does the Report establish that NIF has the technical capabilities to lead to vertical proliferation, yet the Report offers detailed solutions to "managing" this non-existent problem. This is a serious deficiency...It is a grand leap from the conclusion that NIF will improve understanding of weapons physics to one that NIF raises vertical proliferation concerns. How will NIF increase numbers, yield or 'development of a next generation of weapons.... The report seems to implicitly adopt the position taken by many anti-nuclear activists regarding what constitutes 'vertical proliferation'." (Chandler, WC2, p. 1)

The term 'vertical proliferation' in this study refers to increases in the numbers of nuclear weapons or warheads or the development of new types of nuclear weapons (advanced weapon concepts). The United States is now in an era of no new nuclear weapon development and of rapid dismantlement of nuclear weapons and warheads. The purposes of stockpile stewardship - to maintain the safety and reliability of remaining U.S. nuclear weapons without nuclear testing - is not considered vertical proliferation.

(20) The description of "new" nuclear weapons is not clear in the report. It appears the United States is still developing new nuclear weapons.

"We are also very concerned about the definition of new weapon or new weapon type...I think it could be clarified and would help in our questions on proliferation risk." (Eldredge, PM5, p. 79)

"What role could ICF play in a weapons program which plans to, or may, introduce a new warhead into its

arsenal, where the new warhead is 'of the same family' as an existing fully tested and stockpiled weapon?" (Cochran, WC2, p. 2)

"A point emphasized in the Draft Study is that the NIF must be viewed in the broader context of the U.S. arms control efforts.... This position is paradoxical in light of the Draft Study's narrowing of scope to exclude other U.S. efforts to improve nuclear weapons research, development, and testing capabilities. The messages sent by the United States concerning the trajectory of its nuclear weapons policy, moreover, have been decidedly mixed." (Western States Legal Foundation, WC2, p. 8-9)

"[The report] says no new designed nuclear warhead production.... Frankly, I don't believe that... First of all, the definition of a new weapon is kind of a slippery slope. Just last week we found out that the B-53, 9 megaton doomsday bomb is being replaced with a more modern... safer B-61 modification that apparently is an earth penetrator... It sure looks like a new weapon to us... [It is] infinitely more useable than the old doomsday, 9 megaton B-53 bomb... This year,... a high powered radio frequency warhead, which, I believe, implicates some of the same technologies that the NIF would employ, reached an engineering decision...that weapon was in fact in the pipeline."(Cabasso, PM7, p. 127-9)

"This study asserts ...that...the administration is not intending to develop new weapons, and I have two questions related to that. First is, how can this study deal with the ongoing nuclear weapons development, ongoing R&D that is happening today, everything from the B53 -- proposed replacement of the B53 in the arsenal with an advanced earth-penetrator warhead to other studies that are just concluding or still ongoing for weapons like the high-powered radio frequency warhead, and so one -- one can go through the budget and simply pick out all of this weapons-development work. So that's number one, the assertions...are incorrect at this time." (Kelley, PM6, p.21)

The study has been amended to clarify the term, "new nuclear weapon" (page 14). A new nuclear weapon would involve a substantially new warhead design concept or advanced weapon concept (a new <u>type</u> of nuclear weapon). Repackaging an existing design to add additional safety features or to remedy an aging defect should not be considered to be development of a "new nuclear weapon" since it is not a new warhead design concept nor an advanced weapon concept. For example, the B-61 replacement for the earth penetrating capability of the to-be-retired B-53 is not a new warhead design concept and is a replacement of an existing military capability with modern, safer, more reliable technology. On the other hand, a high powered radio frequency weapon would be a "new nuclear weapon" and falls into the category of a "new weapon <u>type</u>" or "advanced weapon concept." Although the Departments of Energy and Defense recently concluded a phase 2 feasibility study for a high power radio frequency type weapon, no development of an actual weapon is planned. The United States is now in an era of no new nuclear weapon development and of rapid dismantlement of nuclear weapons and warheads.

(21) NIF can be used to develop pure fusion weapons.

"[The] question is why are two obvious categories in new weapons left out of your list? Number one is what led to NIF in the first place, and that is the decisions at Livermore... to go all-out to try to find ways to make

pure-fusion explosives. That led to inertial confinement fusion." (Taylor, PM7, p. 45)

"Meeting the stated NIF goal of producing fusion explosions, of any size, that release more energy than used to cause them would clearly be an important step in the direction of developing pure fusion weapons. I see no guarantees that the kinds of new knowledge that would be derived from inertial confinement fusion experimental programs would not help stimulate new ideas regarding ways to concentrate the needed energy in much smaller packages. Successful pursuit of such ideas in the U.S. or elsewhere, could have extreme global consequences." (Taylor, WC2, p. 2)

"If it achieves the NIF goal of releasing more energy in a fusion explosion than needed to produce it, such a device could qualify as a pure fusion weapon, even though it would be much bigger and heavier than any practically deliverable warhead or bomb." (Taylor, WC2, p. 2)

The conditions needed for fusion ignition in an ICF capsule - i.e. the temperatures and energy densities - are generally already widely known. Research at NIF might provide some useful information on whether these conditions can be achieved with a laser driver. However, for two reasons, NIF would not be sufficient to develop a pure fusion weapon: (1) NIF targets are much too small to be a weapon; and (2) the driving mechanisms and conditions that would be required for a deliverable pure fusion weapon are entirely different than those required for ICF. The fundamental problems in developing the most complicated part of a pure fusion weapon, namely, the driver, have to do with high explosive-driven hydrodynamics, hydrodynamic instabilities and magnetohydrodynamics on a much larger scale.

(22) NIF can be used to develop mini-nuclear weapons.

"...the Pandora's box that's being opened [by ICF research at NIF] is moving toward new kinds of weapons ... which capitalize on the nature of modern military and civilian technology to use very little energy to do an enormous amount of damage with small explosions." (Taylor, PM7, p. 117)

Most concepts for mini-nukes are single-stage, fission-only devices. As the report explains, NIF lacks basic relevance for these weapons. Even for mini-nuke concepts that involve both fission and fusion, the same reasoning which applies to NIF's limited relevance to weapons development for nuclear weapons relates to NIF's relevance to fission-fusion mini-nukes - i.e., the fission trigger would still be much larger than an ICF capsule, the driving conditions are different than in a mini-nuke and the energy densities are still less than a thermonuclear weapon. (See the study section entitled "Approach of Technical Analysis".) Research and development on mini-nuclear weapons is currently banned by legislation.

(23) The NIF has applicability to developing EMP and microwave weapons.

"...there's nothing in there [the report] about what seems to be the most -- to many people who attend conferences, the most exciting category of nuclear weapons and non-nuclear weapons today, and that is those that produce electromagnetic pulses that can be directed with antennas, that can play all kinds of new roles in high altitude or space warfare." (Taylor, PM7, p. 46)

"The study contains no discussion of the role that the NIF project and possible extensions of it might play in the development of new types of nuclear or non-nuclear weapons: In particular, no attention is given to possible directed energy weapons that use NIF-like technology to energize extremely high power, narrow beams of microwaves." (Taylor, WC2, p. 2)

"...the NIF facility as a whole represents a possible, very effective, long-range-effect nuclear weapon, the whole facility. It's a pulse power source... [that could] drive a microwave weapon that is sitting right next to it... upward at space targets." (Taylor, PM7, p. 48)

Electromagnetic pulse (EMP) and microwave weapons are types of directed energy weapons. The study addresses the relevance of NIF to these types of weapon concepts on pages 19-20. under the heading, "X-ray Laser Research", in the section entitled, "What weapons science do U.S. weapons scientists believe is technically possible on NIF?" This section concludes that "experiments on directed energy weapon concepts are considered highly speculative and NIF would only be able to play a very limited role in addressing some of the physics aspects of such weapons, and then, only on a small laboratory scale" (p. 20). As with other advanced weapon concepts, full-scale nuclear testing would be needed to develop directed energy weapons, including EMP and microwave weapons, and place them into the stockpile with a tolerable level of confidence.

On the specific weapon concept that proposes using the output energy from ignited NIF capsules to drive microwave converters, NIF capsules would not produce enough energy to be effective for such an application and there are much more efficient and practical means to produce microwave energy, for example, by using high explosive drivers or charging up capacitor banks with the local electric company.

(24) NIF will cause a continuation of the arms race among the nuclear weapon states.

"... other NWSs [nuclear weapon states] like Russia are more likely to experience our SBSS [Science-Based Stockpile Stewardship] program as pressure to duplicate a high level of investment in nuclear weapons design and development programs, tailoring the nature of their investments to suit their particular situation." (Mello, WC1, p. 4; also Mr. and Mrs. Leonard, WC1, p.1)

"... the NIF will serve to increase the power of those military hard-liners in Russia who also wish to continue nuclear weapons research." (Pilisuk, WC1, p. 2, WC2, p.2)